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Surgical decision making in a teaching hospital: a linguistic analysis

Running head:

Surgical decision making

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Abstract

Background: The aim of the study was to gain insight in the involvement of non-operating surgeons in intra-operative surgical decision making at a teaching hospital. The decision to proceed to clip and cut the cystic duct during laparoscopic cholecystectomy was investigated through direct observation of team work.

Method: 11 laparoscopic cholecystectomies performed by consultant surgeons and specialty trainees at a London teaching hospital were audio and video recorded. Talk among the surgical team was transcribed and subjected to linguistic analysis, in conjunction with observational analysis of the video material, sequentially marking the unfolding operation.

Results: Two components of decision making were identified, participation and rationalisation. Participation refers to the degree to which agreement was sought within the surgical team prior to clipping the cystic duct. Rationalisation refers to the degree to which the evidential grounds for clipping and cutting were verbalised.

Conclusion: The decision to clip and cut the cystic duct was jointly made by members of the surgical team, rather than a solitary surgeon in the majority of cases, involving verbal explication of clinical reasoning and verbal agreement. The extent of joint decision making appears to have been mitigated by two factors: trainee's level of training and duration of the case.

Introduction

Competent and safe decision making during operations is a basic requirement of safe surgical practice¹. The majority of studies on intra-operative decision making have focused upon understanding the cognitive processes of individual lead-surgeons as they make decisions. These processes have been explored through interviews and ‘think aloud’ commentary during the operation or by recall using laparoscopic recordings as stimuli. Studies have identified strategies used by individual surgeons to make decisions and the relative frequency of occurrence of these strategies by surgeons with different levels of experience and in different circumstances²⁻⁶.

These prior studies highlight individual surgeons’ recollections, assessments and reflections on their own cognitive processes. The findings reported here investigate audio and video recordings of operations. This approach aims to provide insight in the decision making process through a detailed linguistic analysis of talk and interaction among surgeons and their team during operations. Although a solid prospect for research into surgical practice, to date, only a handful of studies have utilised linguistic analysis or a similar approach⁷⁻⁸.

A linguistic perspective suggests that while frequently assumed to be the exclusive domain of the lead surgeon⁹, operating surgeons often invite decision making input from other team members. This is usually demonstrated by a form of commentary where surgeons talk through their actions¹⁰⁻¹¹. For instance, surgeons verbally articulate what they see (e.g. “That must be the cystic duct”), what course of action they are considering (e.g. “Shall I take that down?”), and how they assess the dissection (e.g. “I have a nice window”). Comments like these (which in layman’s terms could be described as ‘thinking aloud’) provide co-present others—assistants, supervisors, observers—with explicative insights into the decision making process.

As another layer of verbal checking, surgeons’ ongoing commentary can potentially improve patient safety. For instance, by checking that co-present surgeons, including trainees, are in agreement that a ‘critical view’¹² has been obtained prior to clipping the cystic duct, the risk of misidentifying the common bile duct for the cystic duct may be reduced. However, to benefit

from perspectives of the wider surgical team a 'safe' climate must be established in which team members feel free to speak up and voice their view, regardless of hierarchical relations, even if that implies disagreement with what more senior members of the team are proposing¹³.

As well as providing an opportunity for non-operating co-present surgeons to participate in decision making, verbal explication may contribute to improved training as it exposes trainees to clinical reasoning. Trainees have reported this to be a characteristic of good teaching in the operating theatre¹⁴. At the same time, by inviting trainees to express their views consultants can assess their understanding of the procedure. Thus, even if other members of the surgical team are unable to contribute to the decision making, the explication of the clinical reasoning, both by the operating surgeon and others, is potentially available to all in the theatre and beneficial educationally.

Methods

This study was carried out in a major London teaching hospital. The data were collected jointly by a linguist/educationalist and a clinical researcher/specialty trainee (ST7). The study was exploratory, set up to generate rather than to test hypotheses¹⁵. No attempt was made to be comprehensive, or to capture a representative sample in a statistical sense. In total, 122 operations in general surgery have been observed. Within this sample the most frequently captured operation was laparoscopic cholecystectomy. 11 laparoscopic cholecystectomies were audio and video recorded. A wireless microphone was worn by at least one of the surgeons. The laparoscope camera was used to capture the intra-coporeal instrument movements. All staff in the operating room and all patients involved gave informed consent. Participants were aware that it was a surgical educational study, not that decision making and the clipping and cutting of the cystic duct in laparoscopic cholecystectomy would be under scrutiny. Ethical approval was granted by the UK National Health Service Research Ethics Committee (ref nr 10/H0712/1).

The sample of 11 cases involved 4 different consultants, 4 different specialty trainees and 3 different core trainees. Table 1 details the operating

time (in minutes) for each case (this was calculated from the point that the laparoscope was inserted into the body cavity until the point it was taken out again), the time that the cystic duct was clipped (as minutes into the operating time), and who was involved in what role (operating surgeon/supervising surgeon/first assistant) when the duct was clipped.

[insert Table 1 here]

Operations lasted between 18min and 1hr34min. The mean (recorded) operating time was 53min. Mean time taken before cystic duct was clipped was 33 minutes. The total number of hours of video-recorded operating time that was available for analysis was 9hrs and 43min. In 7 cases a consultant was the operating surgeon (CASE 1-3 and 5-8), while in 4 cases a specialty trainee was the operating surgeon. Three cases (CASE 9-11) were performed by a trainee under supervision. In two of these cases (CASE 9; 11) the consultant was scrubbed. In one case (CASE 10) the consultant did not scrub. In one case (CASE 4) a specialty trainee at near-consultant level was the operating surgeon in the absence of a supervising consultant. While the sample was small compared to other studies, it is analysed at a much greater level of detail, enabling the identification of phenomena that otherwise go unnoticed. The results can be tested through further research on a larger scale.

All cases were reviewed in their entirety by JB and AC. They transcribed the spoken interaction of all cases. A subsample was then created of clips immediately preceding and capturing the clipping and cutting of the cystic duct, starting at the point where the 'critical view of safety' is being assessed, as this is a critical, known decision point in laparoscopic cholecystectomy. These video clips were reviewed by JB, AC and GM (also a linguist). Linguistic tools were used to transcribe and analyse the recordings in detail¹⁶. The instrument movements and their effects on anatomical structures were also described, so that the talk could be analysed in conjunction with the unfolding of the procedure. Through joint, iterative engagement with the detailed transcriptions of the cases basic categories were identified by JB, GM, AC and RK. This so-called thematic analysis is a common approach in

qualitative research¹⁷. It is an inductive process by which emerging categories are constantly compared against further cases and redefined accordingly, until they are congruent with, i.e., accurately represent the entire sample. Following this approach two dimensions were identified, along which the decision making of the clipping of the cystic duct could be described across the 11 cases. Patterns in the data were then explored with reference to the training level of the trainees involved in the cases and the complexity of the cases. The analysis has been validated by RK (Professor of surgical education).

Results

Two component features of decision making in relation to clipping of the cystic duct were identified: participation and rationalisation.

Participation refers to the degree to which agreement was sought prior to clipping and cutting the cystic duct. Decisions were qualified as 'unilateral' when no agreement was sought, and as 'multilateral' when comments were made that were explicitly designed to invite others to participate in the decision making process.

Agreement was sought in 7 out of 11 cases. Out of these 7 cases of multi-lateral decision making, 6 cases involved a consultant and a specialty trainee (ST4 or higher) or staff grade level surgeon. Out of these 6, 3 cases were carried out by an operating consultant, while the other 3 cases were carried out by an operating specialty trainee under the supervision of a consultant. The other multi-lateral decision involved an operating consultant and an assisting core trainee. In all 7 cases where agreement was sought it were the consultants who did so, whether they were operating or supervising. Where agreement was sought by the consultant, there was a definite preference for agreement from other team members ('yes', 'yes, very', 'perfect') in 5 out of 7 cases. In one case an assisting surgeon at staff grade level responded suggesting to clear Calot's triangle more, but this was rejected by the consultant. In the only case where agreement was sought from a core trainee the trainee did not respond.

In 4 of the 11 cases no agreement was sought. All of these cases were carried out by consultants who were assisted by a core trainee or, in one

case, by a ST3. Thus consultants always sought agreement from assisting trainees at ST4 level and above prior to clipping the cystic duct. Only in one case did a consultant seek the agreement from an assisting core trainee. This suggests a threshold for getting involved in decision making that is based on level of training.

Rationalisation refers to the verbal explication of (visual) evidential grounds justifying a decision to clip. Decisions were described as 'implicit' where evidential grounds were not verbally articulated. Where they were, decisions were described as 'explicit'. Rationalisation typically involved naming the cystic duct ('that's the duct') and describing defining features ('it's going into the gall bladder') while pointing at the presumed duct with an instrument; and by assessing the dissection ('that's the view you want'; 'You've got a nice big window') referring to the critical window between the gallbladder and liver.

Rationalisation occurred in 9 out of 11 cases, including cases of operating consultants with core and specialty trainees as assistants and cases of trainees operating under supervision. In 2 cases no verbal explication of clinical reasoning was given. One of these cases was led by a consultant, assisted by a ST4, and the other one by a specialty trainee at near-consultant level (ST7), assisted by a ST5. Thus while participation appears to have been related to the training level of the assistant, rationalisation was not. Instead, the factor affecting rationalisation seems to be the duration of the case (which might be an indicator of individual case complexity, a more difficult laparoscopic cholecystectomy taking longer than an easy one). The two cases where no rationalisation was observed were both exceptionally short cases, taking less than 20min each, whereas the average operating time of the other 9 cases was 61min. Indeed, in the two quick cases Calot's triangle was encased in little fat, the cystic ducts were long and thin, and the critical window opened up with minimal effort. In cases like this where, due to anatomical structure, the grounds for clipping were self-evident, surgeons refrained from verbally explicating their reasoning.

While verbal explication varied across cases, in all cases (including the two short cases) operating surgeons were found to make a distinctive 'gesture' with their instrument to suggest that the cystic duct was sufficiently

freed. These instrument movements were not designed to dissect but to check and demonstrate that it was safe to clip the cystic duct. One typical gesture made just before clipping the duct involved sweeping up and down behind the cystic duct with a Maryland as if to 'prove' that the cystic duct was sufficiently freed up with nothing lying behind it.

Based on the two dimensions of participation and rationalisation four types of decision making can be distinguished. Table 2 charts these four types, their frequency of occurrence and the typical duration and the level of the trainees associated with each type. To illustrate these four types of decision making we briefly describe four concrete examples from our data.

[Insert table 2 here]

Example 1: Unilateral, implicit decision making

In Example 1, the operating surgeon (a consultant) does not seek agreement from the assistant (a ST 4), nor does he make his clinical reasoning verbally explicit. Clinical reasoning can only be inferred from what the operating surgeon says and does. The laparoscopic video shows that he has just created a window with a Maryland (with minimal effort) when he requests for a clip applier to be provided by the scrub nurse, signalling that he is expecting to clip soon. This is then reinforced as he asks if the hook diathermy is ready (the instrument he will use to dissect the gall bladder from the liver bed once the cystic duct and artery have been clipped), repeats his request for the clip applier, and notes that he will soon be completing the case. Indeed, after having established that the cystic duct is sufficiently freed up by moving the closed Maryland through the window he just created, opening and closing it twice and moving the closed instrument up and down to establish the critical window, he receives the clip applier and clips the cystic duct.

Example 2: Multi-lateral, implicit decision making

In Example 2, the operating surgeon (a near-consultant level speciality trainee) seeks agreement from the assistant (a ST 5), as well as from the observing researcher (AC, a ST 7), who both indicate that they agree. However, none of them verbally explicate the evidential grounds for clipping.

Using a Maryland he creates a window, with minimal effort. As the critical window opens up, he says, 'there you go'. The assistant responds to this by saying, 'nice'. The operating surgeon then sweeps up and down the cystic duct with the Maryland closed to ensure no structures are hidden behind, while asking, 'Agreed?' The assistant responds affirmatively. He then asks the observing researcher (AC) if she's happy, and she too responds affirmatively. The operating surgeon then acknowledges their responses and 'squeezes' with the Maryland all across the duct to clear the duct of stones, asks for clips, and proceeds to clip and then cut the cystic duct.

Example 3: Unilateral, explicit decision making

In Example 3, the operating surgeon (a consultant) does not seek agreement from the assistant (a ST 3), but he does eventually provide a rationalisation for the decision to clip. That clipping is imminent is first implied by the operating surgeon saying he's 'happy' as he inspects Calot's triangle with a hook. The assistant acknowledges this assessment ('yeah'). The operating surgeon then signals that he will proceed to clip by saying they'll 'try' clips (anticipating that the clips might not go across the relatively wide duct) and by requesting a clip applicator. Prompted by the assistant, the operating surgeon then makes his reading of the anatomy explicit, pointing to the presumed location of the common bile duct with his instrument. He then clips and cuts the cystic artery followed by the cystic duct.

Example 4: Multi-lateral, explicit decision making

In Example 4, agreement is sought and rationalisation provided. In example 4a the operating surgeon (a consultant) initiates rationalisation himself ('that's what you call the critical view'), and some minutes later involves the assistant (a ST 5) in the decision to clip by asking him if he is 'happy' as he inspects the cystic duct with a hook. When the assistant has confirmed he is, the operating surgeon uses a Maryland to squeeze along the cystic duct, reminds the assistant everything is about safety, and requests a clip applicator. As he receives the clip applicator he seeks agreement again, and after the assistant has signalled agreement the operating surgeon proceeds to clip the cystic duct.

This series of examples shows how decision making is signalled through actions and verbal comments, prompting responses from other members of the surgical team. The duration of the cases appears to have affected the degree of *rationalisation* produced by the teams included in this study: in the two short cases (< 20min), where a critical view was obtained with minimal effort as Calot's triangle was encased in little fat, and where the cystic ducts were long and thin (Examples 1-2), the surgeons did not verbally explicate the evidential grounds for clipping the cystic duct. In the other nine cases they explained their rationalisation that the structure they were about to clip must be the cystic duct, rather than common bile duct. The level of the trainees involved in the operation appears to have been a mitigating factor affecting the degree of *participation* in the decision making: consultants always sought agreement from assisting specialty trainees except in one of the two short cases, while only one of the three assisting core trainees was invited to get involved.

Discussion

In the video-recorded laparoscopic cholecystectomies at a major teaching hospital in London, operating and supervising surgeons oriented to an expectation that the decision to clip and cut the cystic duct requires some form of verbal explication of the rationale for that decision. In other words, they treated that decision and the reasoning behind it as an accountable matter. This practice provides trainees with unique learning opportunities: it enables experienced trainees to participate in the decision making, while exposing inexperienced trainees to clinical reasoning, thus enabling them to participate 'peripherally'¹⁸. Indeed, it may be that the hospital's teaching remit has prompted the consultants in this study to invite trainees to participate in the decision making and to provide rationalisations of their decisions.

We acknowledge that the presence of observers may also have had an effect (Hawthorne effect) on the behaviour of the surgeons who participated in the study. While they were not aware of the specific focus of the study, they may have, for instance, involved junior surgeons more in decision making if they believed that these behaviours qualify as 'good practice'. If participation and rationalisation occurred as a result of being observed, this would suggest

that the belief that these are desirable features of surgical (educational) practice is common among the teams observed.

In the data set, only one instance of disagreement was found. This raises a number of questions. First, does verbally expressed agreement always reflect genuine agreement, or is some of the expressed agreement 'token' agreement? Do trainees speak up when they disagree? Junior doctors have reported that they are afraid to speak up to more senior staff¹⁹, and this might explain why disagreement only occurred once-and only by a staff grade surgeon. Second, are trainees inclined to agree with proposals from consultants, without necessarily judging the evidential grounds for the decision themselves? What is the effect of the prompt for a response being formulated as a proposal ('Agreed?'), rather than an 'open' question ('what do you think?')? Third, how do consultants 'weigh' the judgements of trainees? How do the judgements of trainees affect the decision making?

Hierarchies, coupled with significant differences in experience and expertise may have inhibited some of the trainees to express disagreement. Disagreeing with decisions proposed or implied by consultants requires a degree of confidence about one's own judgement and a preparedness to be proven wrong. Appropriate responses to clinical judgements are crucial for developing a safe climate: When clinical judgements of trainees are not taken seriously or dismissed without explanation, the trainees are less likely to speak up in situations where that could have significant implications for the patient. While checklists are designed to encourage communication across hierarchies, team members should be in a position to speak up at any moment before, during or after the operation. That requires changes in the culture of the medical profession²⁰. These are important areas for further research.

The linguistic approach of decision making used here is an important complement to interview-based research²⁷. Linguistic analysis of what is said as surgeons find themselves at a critical juncture in a procedure makes *visible* how cognitive processes become shared and distributed²¹, providing significant opportunities for trainees to learn how to 'think like a surgeon', and for consultants to reflect on their own judgement before making critical decisions. It was also noted that gestures are an integral part of

rationalisation: in all cases a distinct gesture was made signalling that a critical view had been obtained prior to clipping and cutting.

This method can be used more widely to study more and different types of surgical decision making. Further research extending the data sample may shed more light on the variation in the degree of participation and rationalisation of the decision to clip the cystic duct and other decisions across different types of hospitals and countries. It will also enable further testing of the suggested links between variation in the degree of rationalisation and participation on the one hand, and case duration and training level of members of the surgical team on the other.

References

- 1 Francis DMA. Surgical decision making. *ANZ J of Surg* 2009; **79**: 886-891.
- 2 Flin R, Youngson G, Yule S. How do surgeons make intraoperative decisions. *Qual Saf Health Care* 2007; **16**: 235-239.
- 3 Jacklin R, Sevdalis N, Darzi A, Vincent C. Mapping surgical practice decision making: an interview study to evaluate decisions in surgical care. *Am J Surg* 2008; **195**: 689-696.
- 4 Pauley K, Flin R, Yule S, Youngston G. Surgeons' intraoperative decision making and risk management. *Am J of Surg* 2011; **202**: 375-381.
- 5 Cristancho SM, Vanstone M, Lingard L, LeBel ME, Ott M. When surgeons face intraoperative challenges: a naturalistic model of surgical decision making. *Am J Surg* 2013; **205**: 156-162.
- 6 Mitchell L, Flin R, Youngson G, Malik M, Ahmed I. Intraoperative Surgical Decision Making: A Video Study. In: Chaudet H, Pellegrin L, Bonnardel N (eds). *Proceedings of the 11th International Conference on Naturalistic Decision Making, Marseille, France, 21-24 May 2013*. Paris: Arpege Science Publishing: 223-225.
- 7 Moore A, Butt D, Ellis-Clarke J, Cartmill J. Linguistic analysis of verbal and non-verbal communication in the operating room. *ANZ J Surg* 2010; **80**: 925-929.

- 8 Weldon, S-M, Korkiakangas T, Bezemer J, Kneebone R. Communication in the operating theatre. *Br J Surg* 2013; **100**: 1677-1688.
- 9 Fioratou E, Pauley K, Flin R. Critical thinking in the operating theatre. *Theor Issues Ergonomics Sci* 2011; **12**: 241-255.
- 10 Blom EM, Verdaasdonk EG, Stassen LP, Stassen HG, Wieringa PA, Dankelman J. Analysis of verbal communication during teaching in the operating room and the potentials for surgical training. *Surg Endosc* 2007; **21**: 1560-1566.
- 11 Koschmann T, Zemel A. "So that's the ureter." The Informal Logic of Discovering Work. *Ethnographic Studies* 2011; **12**: 31-46.
- 12 Nagral, S. Anatomy relevant to cholecystectomy. *J Min Access Surg* 2005; **1**: 53-58.
- 13 Pronovost, PJ, Thompson DA, Holzmüller CG et al. Toward learning from patient safety reporting systems. *J Crit Care* 2006; **21**: 305-315.
- 14 Cope A. *The pedagogy of the operating theatre*. PhD Thesis. Imperial College London; 2013.
- 15 Reeves S, Kuper A, Hodges BD. Qualitative research methodologies: ethnography. *BMJ* 2008; **337**: a1020.
- 16 Heath C, Luff P, Sanchez Svensson M. Video and qualitative research: analysing medical practice and interaction. *Med Educ* 2007; **41**: 109-116.
- 17 Lingard L, Albert M, Levinson W. Grounded theory, mixed methods, and action research. *BMJ* 2008; **337**: a567.
- 18 Lave J, Wenger E. *Situated learning. Legitimate peripheral participation*. Cambridge: Cambridge University Press; 1991.
- 19 O'Connor P, Ryan S, Keogh I. A comparison of the teamwork attitudes and knowledge of Irish surgeons as U.S. Naval aviators. *Surgeon* 2012; **10**: 278-282.
- 20 Bosk C, Dixon-Woods M, Goeschel CA, Pronovost P. Reality check for checklists. *Lancet* 2009; **374**: 444-445.
- 21 Hutchins E. *Cognition in the wild*. Cambridge MA: MIT Press; 1995.

Case	Operating time	Time of clipping duct	Operating surgeon	First assistant/supervisor
1	29	18	CONS	CT2
2	51	39	CONS	CT1
3	79	42	CONS	CT1
4	18	13	ST7	ST5
5	58	28	CONS	STG
6	12	4	CONS	ST4
7	94	72	CONS	ST5
8	73	44	CONS	ST3
9	40	26	ST4	CONS
10	63	42	ST5	CONS
11	60	33	ST5	CONS

Table 1: Data sample (CONS=Consultant; ST=Specialty Trainee (year of training); CT=Core Trainee (year of training); STG=Staff Grade Surgeon)

		Participation	
		Unilateral	Multi-lateral
Rationalisation	Implicit	n=1 (see Ex 1) ST4 12min	n=1 (see Ex 2) ST5 18min
	Explicit	n=3 (see Ex 3) CT1-ST3 29-73min	n=6 (see Exs 4a & 4b) ST4+ 40-94min

Table 2: Four types of decision making and associated duration of the case and level of trainees